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Growth Performance, Nutrient Digestibility and Haematological Parameters of West African Dwarf Goats Fed Water Hyacinth Ensiled with Breadfruit

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Abstract: Ruminant animal production in the dry season is usually problematic as weight losses are experienced arising from scarcity of forages. Conservation of Water Hyacinth (WH) (*Eicchornia crassipes*) ensiled with Breadfruit (BF) can help to bridge this gap. This study investigated the feeding value of WH ensiled with different levels of BF (at 0, 10, 20, 30 and 40% of the total silage diet mixture) as feed for West African Dwarf (WAD) goats. Chopped WH (2-3 cm) and BF were mixed together while sawdust was included at a constant level of 10% in all treatments and designated as diets 1-5, respectively. The mixture was ensiled for 28 days. A total of 25 growing WAD goats of both sexes (5-7 months old) weighing between 4.25-5.50 kg were randomly allotted 5 experimental diets. Data on proximate composition, growth, nutrient utilization and haematology were collected and subjected to a one way analysis of variance using the General Linear Model (GLM) procedures of SAS while differences between means were separated using the Duncan's multiple range test of the same package. The proximate composition showed significant ($p<0.05$) improvement in all parameters as Breadfruit increased in silage diets except for crude protein and ash. Increasing levels of BF in silage diets had a significant ($p<0.05$) effect on intake. Average daily gain (g/day) for goats were similar in diets 3 (36.36), 4 (39.24) and 5 (37.93) and higher ($p<0.05$) than those for animals on diet 1 (29.48). The feed conversion ratio for goats on diets 1 and 2 (9.65 and 9.53, respectively) were poorer than those (7.86, 7.55 and 7.81) obtained for goats fed diets 3-5, respectively. Nitrogen intake, faecal nitrogen and nitrogen loss (g/day) were higher ($p<0.05$) in goats fed diet 1 than in other diets. Haematological parameters improved as BF increased in silage diets. Glucose values (54.76-86.31 mg/dL) increased ($p<0.05$) across diets while total protein, albumin, urea and creatinine were unaffected by silage diets. Results demonstrated that water hyacinth diets ensiled with Breadfruit have potentials as feed for ruminants with optimum results in silage diets with Breadfruit inclusion levels of 30%.

Key words: WAD goats, silage diets, water hyacinth, Breadfruit, feed intake and growth performance, conversion ratio

INTRODUCTION

It is increasingly important to devise strategies for ensuring continuous accessibility to quality feedstuff by ruminant animals all year round. Inadequate supply of quality forage on a year round basis and high cost of conventional feedstuffs are major problems to the productivity of ruminants in Nigeria (Olorunnisomo, 2008). In many tropical countries, the major feed resources upon which cattle and other ruminants live comes from grazing mainly on poor quality annual and perennial grasses from natural pastures. During the dry seasons, grasses are scarce and in some instances are not available and where available are not adequate to meet the animal's requirement for growth, maintenance and production (Adegbola and Asaolu, 1986). The resultant effect of this is the on and off (staircase) growth rate pattern exhibited by the animals over time which consequently affects the overall productivity of the animals negatively (Babayemi and Bamikole, 2007; Ibhaze and Fajemisin, 2015). Concerted efforts in research has been directed towards mitigating these effects and creating awareness to improve and supplement grasses, especially in the dry season with crop residues and agro-industrial by products as well as the use of legume and browse plants. However, these interventions are also affected by costs, seasonality and availability.

Conservation of forages is a step towards achieving sufficiency and sustainability in ruminant production. One of the conservation methods is the production of silage. Silage production is a form of forage conservation where a forage, crop residue or agricultural by-product is preserved in its near fresh form for later use during the off season period by acids either artificially added or produced by natural preservation in the absence of air (Moran, 2005). Silage making is an important tool for farmers in preservation of surplus feed during the wet season in ensuring all years round availability of feed

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(Ibhaze *et al*., 2015). Many researchers have worked on the production of silages with different forages. One of these forages is *Eichhornia crassipes* (Water hyacinth) which is a rigorous, free floating, fresh water weed of the family Pontederiaceae. This forage's nutritive value is well documented (Akinwande *et al*., 2011). For sustainability sake there is need for conservation of this forage. However, there is dearth of information on its utilization as silage in a conserved form. Inclusion of silage additives helps to improve silage quality and animal performances. Molasses, sugar beet, bagasse and most recently sugar cane have been used as fermentation stimulant. Other additives such as wheat offal, poultry litter, citrus pulp and cassava peels have been documented as additives, however, cost and availability are often a limiting factor. Breadfruit (*Artocarpus artillis*) contains easily fermentable carbohydrates in form of sugars in its matured state and is available in excess of requirement because of its underutilization. The excess constitutes a waste beneath trees during its season. Furthermore, literature is scanty on the utilization of Breadfruit as an additive in silage production. Meanwhile, the environmental impact of water hyacinth and Breadfruit remains a cause for concern.

The objectives of this study was to assess thenutrient digestibility, growth performance and haematological parameters of West African dwarf goats fed water hyacinth ensiled with varying levels of Breadfruit.

MATERIALS AND METHODS

Experimental station and duration: The experiment was carried out at the Sheep and Goat Unit, Obafemi Awolowo University Teaching and Research Farm, Ile-Ife located approximately between latitude 7°31′N and 7° 33′N and longitudes 4°33′E and 4°34′E (Amujoyegbe *et al*., 2008). The experiment lasted 16 weeks.

Silage production and experimental diets: Water Hyacinth (WH) was collected from Itoikin River, Epe road Lagos State. Breadfruit (BF) and Sawdust (SD) were sourced within Ile-Ife town in Osun State, Nigeria. Roots of harvested water hyacinth were discarded while the vegetative parts were wilted and used for making silage after they were chopped into smaller pieces of about 2-3 cm to aid compaction and mixed with chopped Breadfruits at varying inclusion levels of 0, 10, 20, 30 and 40% of the total silage diet while sawdust was included at a constant level of 10%. WH:BF:SD mixture was packed, compacted and sealed in thick polythene bags to create an anaerobic condition for proper fermentation. The silage was ensiled for 30 days after which they were opened. Silage diets (constituting 60% of the total diet) were fed at 8 h while a compounded concentrate diet (remaining 40%) was fed at 15 h.

Experimental animals and their management: A total of 25 growing WAD goats of both sexes aged 5-7 months weighing 4.50±0.34 kg were randomly assigned to 5 experimental diets in a completely randomized design. There were 5 goats per treatment with each animal serving as a replicate. The goats were housed in open sided, well-lighted and adequately ventilated building with slated floor. The house was disinfected before the animals arrived. The animals were vaccinated against pestes des petite buminante, quarantined and observed for any disease symptom for 7 days. The goats were also dewormed and treated against ectoparasites using ivomec®. Prior to the commencement and throughout the experiment, animals were feed at 5% of their body weight. Water was supplied *ad libitum*.

Digestibility, nitrogen balance and growth studies: Digestibility trial was carried out for 2 weeks preceded by 14 days adaptation period with 3 goats randomly selected per treatment and moved into metabolism cages with facilities for separate collection of faeces and urine. The total faeces voided per animal was weighed and aliquot samples taken per day and dried in the oven at 70°C for 24 h for dry matter determination. The daily stored samples of faeces for each animal were bulked, thoroughly mixed, ground and sub-sampled for chemical analysis. The volume of urine by each animal produced was measured daily. The 10% of the daily urine produced was taken and volatilization of nitrogen from urine was prevented by introducing 0.1N of HCl into urine collected and stored in a deep freezer and later analyzed for nitrogen determination. Growth trial lasted 12 weeks. Each animal was weighed using hanging scale and weighing sack before the commencement of the study and subsequently were weighed weekly throughout the experimental period. Parameters measured included feed refusal, feed intake and weight gain.

Blood samples collection and analysis: Blood samples were collected from three animals per treatment via. jugular vein of the animals a week before the commencement of the experiment and 12th week of the feeding trial. Prior to feeding in the morning, bleeding was done to assess blood profile of the animals. About 5 mL of the blood was obtained from each animal with 2.5 mL each collected in a plain and EDTA containing bottles, respectively. Centrifugation of blood collected in plain bottles was carried out according to methods of Mitruka and Rawnsley (1977) to obtain sera. The serum metabolites (glucose, total protein, albumin, urea, bilirubin, calcium, phosphorus and creatinine) were determined according to Randox procedure of chemical analysis (2010). The readings were carried out using photo spectrometer in the laboratory and globulin values were estimated.

Statistical analysis: Data obtained for each parameter was subjected to a one way analysis of variance using the general linear model procedures of SAS (2001) while differences between means were separated using the Duncan's multiple range test of the same package.

RESULTS AND DISCUSSION

Table 1 shows the gross composition (%) of silage diets while Table 2 shows the gross composition of the concentrate diet. The calculated crude protein, crude fibre and metabolizable energy were 13.45, 12.03 and 1447.60 kcal/kg, respectively.

The chemical composition (g/100 g) of experimental diets are shown in Table 3. The dry matter values ranged from 14.21-28.44 g/100 g. Diet 1 had the lowest value 14.21 g/100 g while diets 3 and 4 (28.03 and 28.44 g/100 g) were similar but higher ($p>0.05$) than others. The ash content was highest ($p>0.05$) in diet 1 and progressively reduced as Breadfruit increased across the diets. Ether extract increased with increasing levels of Breadfruit in the diets while the highest ether extract values were observed in diet 5 (2.70 g/100 g). The crude protein values ranged from 12.03% (diet 1) to 9.18% (diet 5). Acid detergent fibre content reduced as Breadfruit increased in diets. Cellulose content of diets also followed the same trend as ADF content.

Apparent nutrient and energy digestibility of WAD goats fed experimental diets are presented in Table 4. The dry matter digestibility values for diets 2-5 were similar but higher ($p<0.05$) than values for diet 1 (67.61%). DDMI values for diets 4 and 5 were significantly ($p<0.05$) higher than value for diet 1. The crude protein and crude fibre intake digestibilities for diet 1 (86.87 and 81.70%, respectively) were significantly ($p<0.05$) higher than for other diets. Ash digestibility, (60.30%) for diet 5 was significantly ($p<0.05$) higher than digestibilities of other diets by goats. The Neutral detergent fibre digestibilities for diets 4 and 1 (66.47 and 63.86 %) were not significantly ($p>0.05$) different but higher ($p<0.05$) than diets 2-5. Diets 1, 4 and 5 had significantly ($p<0.05$) higher acid detergent fibre digestibilities (76.06, 74.17 and 73.81%) than diets 2 and 3 (63.39 and 62.13%). The digestibility of acid detergent lignin by goats was significantly ($p<0.05$) higher in diet 1 (43.88%) than values (26.68, 27.35, 29.33 and 37.35%) obtained for goats on diet 2-5, respectively.

Table 5 shows the growth performance characteristics of WAD goats fed experimental diets. Total Average Daily Feed Intake (ADFI) increased ($p>0.05$) across the diets with increase in Breadfruit. Average final live weight gain ranged from 6.90 kg (diet 1) to 7.60 kg (diet 5). Total weight gain were similar in animals fed diets 3-5 and higher than those fed diets 1 and 2. Average daily gain was significantly ($p<0.05$) affected by silage diets. The feed conversion ratio for goats on diets 1 and 2 (9.65 and 9.53, respectively) were significantly ($p<0.05$) higher than values of 7.86, 7.55 and 7.81 obtained for goats fed diets 3-5, respectively.

Table 1: Gross composition (%) of the silage diets

Ingredients/diets	1	2	3	4	5
Water hyacinth	90	80	70	60	50
Breadfruit	0	10	20	30	40
Sawdust	10	10	10	10	10
Total	100	100	100	100	100

Table 2: Gross composition of the concentrate diet

Ingredients	Proportion (%)
Maize bran	40.0
PKC	24.5
Wheat offal	35.0
Salt	0.25
Premix	0.25
Calculated values	
Crude protein (%)	13.45
Crude fibre (%)	12.03
Metabolizable energy (kcal/kg)	1447.60

Nitrogen utilization of WAD goats fed experimental diets are shown in Table 6. Nitrogen intake, faecal nitrogen and nitrogen loss (g/day) were significantly higher ($p<0.05$) in goats fed diet 1 than other diets. There was no significant difference ($p>0.05$) in nitrogen intake, faecal nitrogen and nitrogen loss values for goats fed diets 2-5. Urinary nitrogen was significantly higher in goats fed diet 4 (0.44 g/day) than for those fed diets 1-3 (0.24, 0.28, 0.27 g/day, respectively). Nitrogen balance in goats was not affected by silage diets. Nitrogen retention (%) was significantly ($p<0.05$) higher in diet 2 (76.75%) than diet 1 (60.02%).

Table 7 shows the haematological profile of WAD goats fed experimental diets. Values obtained for white blood cell count, mean corpuscular heamoglobin concentration, lymphocytes, monocytes and basophils were not significantly ($p>0.05$) affected by diets. Silage diets significantly ($p<0.05$) increased the Packed Cell Volume (PCV) and Hb. The heamoglobin concentration values (8.00 and 7.78g/dL) for goats fed diets 3 and 5 were significantly ($p<0.05$) higher than those observed (6.34, 7.11 and 7.39g/dL) for goats fed silage diets 1, 2 and 4, respectively. Packed cell volume increased from diet 1-5 but was significantly ($p<0.05$) different between animals fed diet 1 and other diets. The Mean Corpuscular Volume (MCV) differed significantly across the diets and ranged between 36.85 and 50.09 fL.

Serum biochemical indices are presented in Table 8. Total protein, albumin, urea and creatinine were unaffected by silage diets. Glucose values ranged from 54.76-86.31 mg/dL and increased as Breadfruit increased in diets. Increase in Breadfruit inclusion in diets resulted in a reduction in bilirubin, calcium and phosphorus values.

Table 3: Chemical composition of experimental diets

Parameters/Diets (g/100 g)	1	2	3	4	5	SEM	Prob.
Dry matter	14.21^{d}	15.99^{c}	28.03^{a}	28.44^{a}	26.64^{b}	0.55	<0.0001
Ash	14.75^{a}	13.80^{ab}	12.86^{bc}	11.72^{c}	9.64^{d}	0.78	0.0003
Ether extract	1.67^{ab}	1.43^{b}	2.42^{ab}	2.53^{a}	2.70^{a}	0.30	0.0499
Crude fibre	21.48^{c}	30.00^{a}	23.21^{bc}	25.25^{b}	15.23^{d}	1.30	<0.0001
Crude protein	12.03^{a}	10.50^{b}	10.72^{b}	10.28^{b}	9.18^{c}	0.26	0.0008
Nitrogen free extract	50.07^{b}	44.27^{c}	50.79^{b}	50.22^{b}	63.25^{a}	2.68	<0.0001
Fibre fractions							
Neutral detergent fibre	50.99^{b}	57.48^{a}	49.14^{bc}	47.03^{d}	43.51^{d}	0.69	<0.0001
Acid detergent fibre	33.16^{b}	38.71^{a}	32.30^{b}	30.74^{b}	23.06^{c}	0.81	<0.0001
Hemicellulose	17.84^{bc}	18.77^{b}	16.84^{cd}	16.29^{d}	20.45^{a}	0.34	<0.0001
Cellulose	30.05^{b}	35.02^{a}	28.90^{b}	27.58^{a}	20.24^{c}	0.77	<0.0001
Acid detergent lignin	3.11^{c}	3.69^{a}	3.40^{b}	3.16^{c}	2.82^{d}	0.05	<0.0001

$^{a-d}$Means within each row with different superscript are significantly different ($p<0.05$); 1 = 0% BF+90% WH+10% SD; 2 = 10% BF 80% WH+10% SD; 3 = 20% BF+70% WH+10% SD; 4 = 30% BF+60% WH+10% SD; BF=Breadfruit; WH = Water Hyacinth; SD = Sawdust; SEM = Standard Error of Mean; Prob. = Probability level

Table 4: Apparent nutrient digestibility of experimental diets by WAD goats

Parameters (%)/Diets	1	2	3	4	5	SEM (±)	Prob.
DM	67.61^{b}	74.67^{ab}	73.21^{ab}	76.21^{a}	80.78^{a}	1.44	0.0294
CP	62.74^{d}	73.47^{bc}	65.42^{cd}	86.86^{a}	79.51^{ab}	2.62	0.0008
CF	81.70^{a}	72.52^{b}	74.67^{ab}	69.06^{b}	74.68^{ab}	1.75	0.0264
EE	75.13	73.74	77.42	70.31	81.86	1.38	0.3268
ASH	52.82^{b}	41.14^{c}	50.43^{b}	42.70^{c}	60.30^{a}	2.06	<.0001
NFE	79.53^{a}	70.86^{ab}	75.50^{a}	61.66^{b}	79.53^{a}	1.34	0.0266
Fibre fraction							
NDF	63.86^{a}	60.82^{b}	54.26^{c}	66.47^{a}	58.66^{b}	0.87	<0.0001
ADF	76.06^{a}	63.39^{b}	62.13^{b}	74.17^{a}	73.81^{a}	1.81	<0.0001
Hemicellulose	55.31^{a}	41.18^{b}	32.79^{c}	52.53^{a}	53.72^{a}	1.46	<0.0001
Cellulose	73.46^{a}	75.46^{a}	77.79^{a}	76.99^{a}	66.34^{b}	1.64	<0.0001
ADL	43.88^{a}	26.68^{c}	27.35^{c}	29.33^{c}	37.35^{b}	1.21	<0.0001

$^{a-d}$Means within each row with different superscript are significantly different ($p<0.05$); 1 = 0% BF+90% WH+10% SD; 2 = 10% BF+80% WH+10% SD; 3 = 20% BF+70% WH+10% SD; 4 = 30% BF+60% WH+10% SD; 5 = 40% BF+50% WH+10% SD ; SD = Sawdust; BF = Breadfruit; WH = Water Hyacinth; SEM = Standard Error of Mean; Prob = Probability level; DM: Digestibility of Dry Matter intake; CP: Digestibility of Crude Protein intake; CF: Digestibility of Crude Fibre intake; EE: Digestibility of Ether Extracts intake; ASH: Digestibility of Ash; NFE: Digestibility of Nitrogen Free Extract; NDF: Digestibility of Neutral Detergent Fibre ADF: Digestibility of Acid Detergent Fibre; Hemicellulos E: Digestibility of Hemicellulose; Cellulose: Digestibility of Cellulose; ADL: Digestibility of Acid Detergent Lignin

Table 5: Growth performance characteristics of WAD goats fed experimental diet

Parameter(s)/Diets	1	2	3	4	5	SEM	Prob
ADFI (g/days)							
Concentrate	145.90^{a}	146.40^{a}	146.79^{a}	139.33^{c}	142.30^{b}	0.92	<0.0001
Silage	135.40^{c}	137.70^{bc}	138.92^{b}	148.50^{a}	149.65^{a}	0.86	<0.0001
Total ADFI	281.30^{c}	284.10^{bc}	285.71^{bc}	287.83^{ab}	291.95^{a}	1.60	0.0019
AILW	4.24	4.53	4.45	4.50	4.41	0.14	0.9603
AFLW	6.90^{b}	7.08^{b}	7.50^{a}	7.80^{a}	7.60^{a}	0.11	<0.0001
TWG (kg)	2.47^{c}	2.54^{bc}	3.05^{ab}	3.30^{a}	3.19^{a}	0.17	0.0079
ADG (g/day)	29.48^{c}	30.29^{bc}	36.36^{ab}	39.24^{a}	37.93^{a}	2.07	0.0080
FCR	9.65^{a}	9.53^{a}	7.86^{b}	7.55^{b}	7.81^{b}	0.54	0.0230

$^{a-d}$Means within each row with different superscript are significantly different ($p<0.05$); 1 = 0%BF+90%WH+10%SD; 2 = 10%BF+80%WH+10%SD; 3 = 20%BF+70%WH+10%SD; 4 = 30%BF+60%WH+10%SD; 5=40%BF+50%WH+10%SD; SD = Sawdust; BF = Breadfruit; WH = Water Hyacinth; SEM(±):Standard Error of Mean; PROB: Probability level; ADFI: Average Daily Feed Intake; AILW: Average Initial Live Weight; AFLW: Average Final Live Weight; TWG: Total Weight Gain; ADG: Average Daily Gain; FCR: Feed Conversion Ratio

Table 6: Nitrogen utilization of WAD goats fed experimental diet

Parameter(s)/Diets	1	2	3	4	5	SEM	Prob
Nitrogen intake (g/day)	3.39^{a}	2.57^{b}	2.63^{b}	2.62^{b}	2.47^{b}	0.19	0.0409
Feacal nitrogen (g/day)	1.12^{a}	0.33^{b}	0.49^{b}	0.35^{b}	0.48^{b}	0.13	0.0108
Urinary nitrogen (g/day)	0.24^{b}	0.28^{b}	0.27^{b}	0.44^{a}	0.34^{ab}	0.04	0.0215
Nitrogen loss (g/day)	1.35^{a}	0.61^{b}	0.77^{b}	0.79^{b}	0.81^{b}	0.14	0.0326
Nitrogen balance (g/day)	2.04	1.96	1.85	1.82	1.65	0.19	0.6570
Nitrogen retention (%)	60.02^{b}	76.75^{a}	70.09^{ab}	69.49^{ab}	67.28^{ab}	4.57	0.2186

$^{a-d}$Means within each row with different superscript are significantly different ($p<0.05$); 1 = 0%BF+90%WH+10%SD; 2 = 10%BF+80%WH+10%SD; 3 = 20%BF + 70%WH+10%SD; 4 = 30%BF+60%WH+10%SD; 5 = 40%BF+50%WH+10%SD; SD: Sawdust; BF: Breadfruit; WH: Water Hyacinth; SEM: Standard Error of Mean; PROB: Probability level

Table 7: Haematological profile of WAD goats fed experimental diets

Parameter (s)	1	2	3	4	5	SEM	Prob
Hb (g/dL) Initial	11.16	11.19	10.53	10.54	10.52	0.81	0.9384
Hb (g/dL) Final	6.34[b]	7.11[ab]	8.00[a]	7.39[ab]	7.78[a]	0.34	0.0437
RBC ($\times 10^{12}$/L) Initial	10.67	10.42	10.17	10.17	9.81	0.67	0.9167
RBC ($\times 10^{12}$/L) Final	6.34[ab]	5.92[b]	6.04[b]	6.48[a]	6.32[ab]	0.14	0.0433
PCV (%)	19.67[b]	22.66[a]	24.33[a]	24.00[a]	24.00[a]	0.89	0.0218
WBC ($\times 10^{9}$/L)	6.70	6.52	6.45	6.57	6.88	0.17	0.4732
MCV (fL)	36.85[b]	46.40[ab]	50.09[a]	43.90[ab]	45.11[ab]	3.73	0.0280
MCHC (g/dL)	32.18	31.31	32.99	30.78	32.27	1.93	0.9325
Lymphocytes (%)	69.33	68.00	69.33	69.30	67.67	0.78	0.4053
Neutrophils (%)	28.00[bc]	31.67[a]	26.00[c]	27.67[bc]	30.00[ab]	0.98	0.0185
Eosinophil (%)	1.00[b]	1.67[ab]	2.00[a]	1.33[b]	1.33[b]	0.44	0.5962
Monocytes (%)	2.00	1.67	1.33	1.67	1.67	0.47	0.6169
Basophils (%)	0.08	0.08	0.07	0.06	0.03	0.04	0.8759

[a-d]Means within each row with different superscript are significantly different (p<0.05); 1 = 0% BF+90% WH+10% SD; 2 = 10% BF+80% WH+10% SD; 3 = 20% BF+70% WH+10% SD; 4 = 30% BF+60% WH+10% SD; 5 = 40% BF+50% WH+10% SD ; SD = Sawdust; BF = Breadfruit; WH = Water Hyacinth; SEM(±): Standard Error of Mean; PROB: Probability level; Hb: Heamoglobin; PCV: Packed Cell Volume; RBC: Red Blood Cell; WBC: White Blood Cell; MCV: Mean Corpuscular Volume; MCH: Mean Corpuscular Heamoglobin; MCHC: Mean Corpuscular Heamoglobin Concentration

Table 8: Serum biochemical response of WAD goats fed experimental diets

Parameters	1	2	3	4	5	SEM	Prob.
Glucose (mg/dL)	54.76[c]	61.48[b]	62.93[b]	63.26[b]	86.31[a]	2.10	<0.0001
Total Protein (g/dL)	10.00	11.14	10.00	11.97	10.31	0.72	0.2932
Albumin (g/dL)	4.55	4.57	4.12	3.72	4.30	0.30	0.3219
Globulin (g/dL)	5.45[b]	6.58[ab]	5.88[ab]	8.28[a]	6.01[ab]	0.72	<0.0001
Bilirubin (mg/dL)	2.02[a]	1.98[a]	1.97[a]	1.11[b]	1.19[b]	0.05	0.0407
Urea (mg/dL)	17.56	18.47	18.01	18.36	17.90	1.06	0.9718
Calcium (mg/dL)	10.31[a]	11.68[a]	9.94[a]	6.94[b]	7.13[b]	0.58	0.0006
Phosphorous (mg/dL)	15.02[a]	13.25[ab]	11.47[bc]	11.54[bc]	8.89[c]	0.89	0.0076
Creatinine (mg/dL)	0.87	0.85	1.02	0.74	0.77	0.14	0.6562

[a-d]Means within each row with different superscript are significantly different (p<0.05); 1 = 0% BF+90% WH+10% SD; 2 = 10% BF+80% WH+10% SD; 3 = 20% BF+70% WH+10% SD; 4 = 30% BF+60% WH+10% SD; 5 = 40% BF+50% WH+10% SD SD = Sawdust; BF = Breadfruit; WH = Water Hyacinth; SEM (±): Standard Error of Mean; PROB: Probability Level

Chemical composition of experimental diets: The increase in dry matter with increasing inclusion levels of Breadfruit may be attributed to the relatively high dry matter of Breadfruit 73.4 g/100 g and the low dry matter content of water hyacinth. The dry matter values obtained were similar to values of 24.2-33.4% obtained by Tham *et al*. (2012) for fresh water hyacinth and also similar to values of 29.95-38.92% reported for ensiled and unensiled 4, 6 and 8 weeks regrowth vetiver grass (Falola *et al*., 2013). Dry matter value of 28.44% obtained in diet 4 is similar to the value of 25.35% obtained by Aboud *et al*. (2005) who ensiled water hyacinth with molasses at 20% inclusion level. The high ash value obtained in this study may be attributed to high rate at which effluents flow into the water body and water hyacinths ability to mop up excess nutrients from its surrounding water body. The high ash content of water hyacinth indicates that the plant will be a good source of minerals. Crude Protein (CP) levels of silage diets obtained in this study were lower than the values of 12-16 % reported by Reza and Khan (1981) for water hyacinth fed to cattle. These differences may be due to geographical differences, human activities around the water body in which the plants thrive and the stage of maturity of the plant when fed. The reduction in CP levels of diets as Breadfruit inclusion increased may be attributed to the low crude protein content of Breadfruit, However, the CP content of diets meets the protein requirement for ruminants which is 8 g/100 g DM (NRC., 1981). High Nitrogen Free Extract (NFE) in diet 5 may be attributed to the high inclusion level of Breadfruit which in turn increased the carbohydrate fraction in terms of NFE.

Apparent digestibility of nutrients by WAD goats fed experimental diets: The Dry Matter (DM) digestibility of fresh or dried water hyacinth is usually low, ranging between 47-58% (Abdelhamid and Gabr, 1991; Hira *et al*., 2002). However, Silage made from water hyacinth is more digestible with DM digestibility values of 67 and 64% obtained in water buffalo and sheep, respectively (El-Serafy *et al*., 1980). However, dry matter digestibility (67.61-80.78%) obtained in this study were higher than those reported for buffalo and sheep (El-Serafy *et al*., 1980) and for sheep fed ensiled water hyacinth as a replacement for para grass but similar to values of 67.35-55.91% reported for WAD goats fed agro industrial by-products and Pennisetum purpureum hay as dry season feed (Obe and Yusuf, 2017). The higher DM digestibility in diets with increase in additive could be as a result of the fermentation process due to the fermentable carbohydrates from the Breadfruit additive. This corroborates the findings of Bereenok *et al*. (2012) who reported that the use of molasses as a silage additive was associated with a significantly higher DM digestibility compared to the silage without additive. High protein digestibility also observed agrees with the earlier observation of Sayed (2009) who reported that an increase in the dietary protein intake level may cause changes in the process of rumen fermentation and allow more protein digestibility. It also agrees with results of Geerts *et al*. (2004) who found that nutrient digestibility of diets increased with increasing crude protein content. This observation agrees with the conclusion of Arigbede *et al*. (2005) and Fasae (2005) that protein supplementation enhanced digestibility. Furthermore, the crude fibre digestibility values (69.06-81.73%) in this study were similar to the values (68.04-76.14%) reported by Ahamefule and Elendu (2010) who fed Cassava Leaf-Maize Offal Based Diets to WAD bucks. Differences observed in the fibre digestibility of diets by animals may be as a result of variation in NDF and ADF contents of the experimental diet based on the increasing levels of Breadfruit and corresponding decrease in water hyacinth across silage diets. These results agrees with the observation of Norton (2003) who reported that the fibre fraction of food has the greatest influence on digestibility. The digestibility of Neutral detergent fibre (54.26-66. 47%) obtained in this study were similar to values (65.6-66.7%) reported by Thu (2016) for water hyacinth silages fed to sheep.

Nitrogen utilization of WAD goats fed experimental diets: Nitrogen balance is described as a good indicator of the protein value of a diet (Babayemi and Bamikole, 2007). All the diets in this study had positive nitrogen balances which indicated adequacy in protein requirement for maintenance. The nitrogen balance obtained in this study were higher than 1.34-1.69 g/day obtained by Babayemi and Bamikole (2007) when Tephrosia bracteolata was fed to WAD goats. It was however lower than values of 2.75-3.75 reported by Oni *et al*. (2010). Nitrogen retention is the proportion of nitrogen utilized by farm animals from the total nitrogen intake for body process, hence the more the nitrogen consumed and digested, the more the nitrogen retained and vice versa. This trend was also observed by Okeniyi *et al*. (2010).

Performance characteristics of WAD goats fed experimental diets: Reports by Ajayi *et al*. (2005) and Ososanya (2010) indicated that feed intake is an important factor in the utilization of feed by livestock. The total average daily feed intake of silage diets by goats in this study increased as the inclusion levels of Breadfruits increased in the diets. This observation agrees with the report of Yousuf and Adeloye (2011) who observed that intake of feeds by goats depend on palatability and fibre content of the diets. The use of Breadfruit as source of fermentable carbohydrate in the silage diets improved the palatability and subsequent intake. Baldwin *et al*. (1975) reported that using very palatable materials in ensiling increased the acceptability of diets by animals. Animals in all the treatments maintained a positive weight gain. The daily weight gains in this experiment were good when compared with the results of Ajayi *et al*. (2005) who obtained 23.81-46.64 g/day for West African Dwarf goats fed Mango (*Mangifera indica*), Ficus (*Ficus thionningii*), Gliricidia (*Gliricidia sepium*) foliages and concentrates as supplements to basal diet of Guinea grass (*Panicum maximum*). The Average daily gain (29.48-39.24 g/day) obtained in this study were higher than values (12.2-25.6 g/day) obtained by Mako (2013) who fed sun cured water hyacinth replacing guinea grass up to 90%. Similarly, the result of FCR revealed that the WAD goats fed 20, 30 and 40% inclusion levels of Breadfruit utilized the diets for body weight gain better than those fed 0 and 10% Breadfruit inclusion levels. The positive response obtained for average daily weight gain and feed conversion ratio in goats fed silage diets with 20, 30 and 40% inclusion levels of Breadfruit could be probably used to further attest the superiority of goats on those diets in terms of nutrient utilization for body weight gain over animals fed diets 1 and 2.

Haematological profile of WAD goats fed experimental diets: The haemoglobin content (10.52-11.19 g/dL) obtained in this study before the experiments were higher than the values obtained at the end of the experiment (6.34-8.00 g/dL). Values obtained before the experiment were in the range of values (7-15 g/dL) reported by Daramola *et al*. (2005). The final value of 6.34 g/dL obtained for goats fed WH silage without Breadfruit was lower than the normal physiological ranges reported by Daramola *et al*. (2005) for WAD goats this may be attributed to heamolytic effect of WH silage on WAD goats. Except for diet 1, the values for Packed Cell Volume (PCV) obtained for goats in this study were within the range (21-35%) reported by Daramola *et al*. (2005). These values were however, lower than values (28.80-35.60%) reported by Ayandiran *et al*. (2012) and (25.86-32.40%) reported by Goska *et al*. for bunaji bulls fattened on varying inclusions of groundnut haulms and maize offal. The Red Blood Cell (RBC) obtained after the feeding trial was lower than the normal physiological range ($7.5\text{-}15.0\times10^{12}$/L) which also indicate the heamolytic effect of the silage diets on WAD goats. The reduction in red blood cells in goats fed silage diets indicates that oxygen carrying capacity of red blood cells was interfered with and perhaps, presence of anaemia (Ibrahim *et al*., 2016). White Blood Cell (WBC) counts obtained in this study were within normal physiological range ($4.0\text{-}12.0\times10^9$/L) reported by Jain and Jain (1993). The RBC, Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH) and mean corpuscular haemoglobin concentrations were within the ranges reported by Daramola *et al*. (2005) for WAD goats. Also the WBC differential counts obtained for goats in this study were within the range reported by Jain and Jain (1993). Factors influencing the haematological parameters of WAD goats are environmental condition (Vecerek *et al*., 2002), dietary content (Odunsi *et al*., 1999), fasting (Lamosova *et al*., 2004), age (Seiser *et al*., 2000), administration of drugs (Khan *et al*., 2001), anti-aflatoxin treatment (Oguz *et al*., 2000) and continuous supplementation of vitamin (Tras *et al*., 2000).

Serum biochemical responses of WAD goats fed experimental diets: The blood glucose level (54.76-86.31 mg/dL) of animals obtained in this study were higher than the range of 45-60 mg/dL reported by Pampori (2003) for clinically healthy goats, however, there were significant ($p<0.05$) reduction in the blood glucose obtained after the feeding trial for diet 1-4, although, it increased with increasing inclusion of Breadfruit this corroborate the findings of Tulika and Mala (2015) who reported anti-diabetic properties of water hyacinth. Serum protein values (6.10-11.14 g/dL) obtained in this study were higher than the range of 6.1-8.5 g/dL reported by Daramola *et al*. (2005) for WAD goats but the total protein observed for goats before the feeding trials were within the range of 6.1-7.5 g/dL reported by Merck. The serum albumin range from this study was similar to the range of 3.90-4.55 g/dL reported for WAD goats by Yusuf *et al*. (2012) but higher than the range of 2.98-3.43 g/dL reported by Okoruwa *et al*. (2014) and Opara *et al*. (2010), respectively. Increase in serum albumin above normal indicates dehydration, impairment in the function of liver, kidneys and digestive system while low albumin suggests poor clothing of blood (Robert *et al*., 2000) and reduction in disease fighting ability of the animal body system which could lead to high mortality (Iheukwumere *et al*., 2005). Differences in serum biochemical parameters of animals in this study may be caused by nutrition, environment and hormonal factors (Chineke *et al*., 2002). Normal enzyme level in serum is a reflection of a balance between synthesis and their release as a result of the different physiological process in the body (Zilva and Pannall, 1984). Serum urea observed for goats in our study (22.09-39.19 mg/dL) is similar to those (20.70-30.04 g/dL and 37.9 g/dL) reported by Okoruwa and Agbonlahor (2014) and Opara *et al*. (2010), respectively. Average lower serum urea concentration may be an indicator of better protein quality (Eggum, 1970) while high level of serum urea has been attributed to excessive tissue protein catabolism associate with protein deficiency (Oduye and Adadevoh, 1976). Treatment diets did not appear to significantly ($p<0.05$) influence the creatinine level in the blood serum of goats, however, the observed increased level of creatinine after the feeding trial may be attributed to decreased kidney function. This explains the effectiveness of body mass function in goats as reported by Okoruwa *et al*. (2014). The increased calcium and phosphorus levels for diets 1 and 2 compared to diets 3-5 can be attributed to the higher inclusion of water hyacinth in diets 1 and 2, since, water hyacinth have been said to be high in mineral content (Mako, 2013).

CONCLUSION

Results demonstrated that water hyacinth diets ensiled with Breadfruit have potentials as feed for ruminants. Diet 4 consisting of 30% BF and 60% WH appears to elicit the best performance in terms of ADWG and FCR. However, some haematological parameters were negatively affected over the period of experiment, hence, diets consisting of WH and BF silage should not be fed for long stretch otherwise, they should be fed with other feed resource that will compensate for water hyacinths heamolytic properties.

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